CH2MHILL

Commercial vs. Industrial Controls for Data Centers

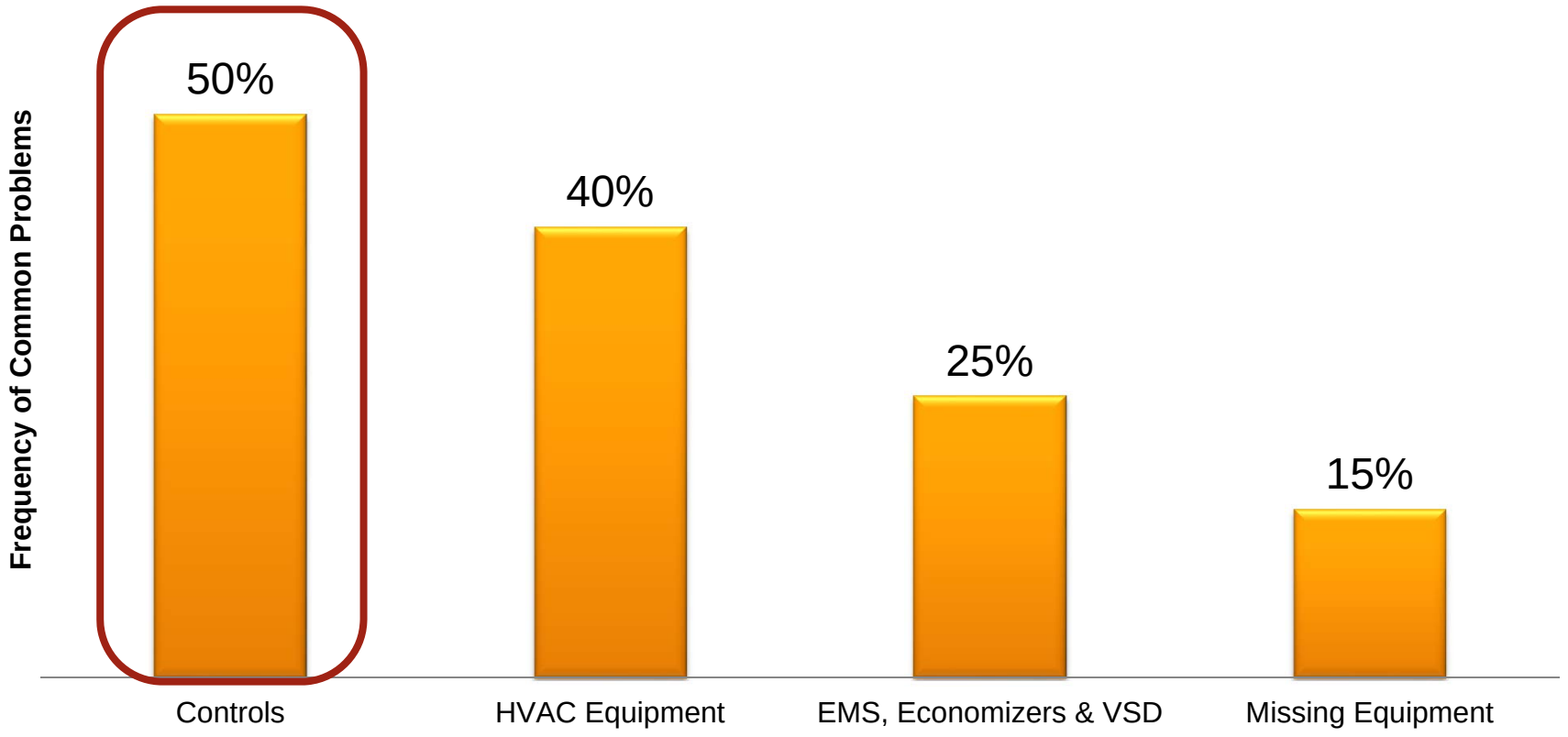
Steve Blaine - P.E.

steve.blaine@ch2m.com

IDC ARCHITECTS

Sources of HVAC Problems

CH2MHILL

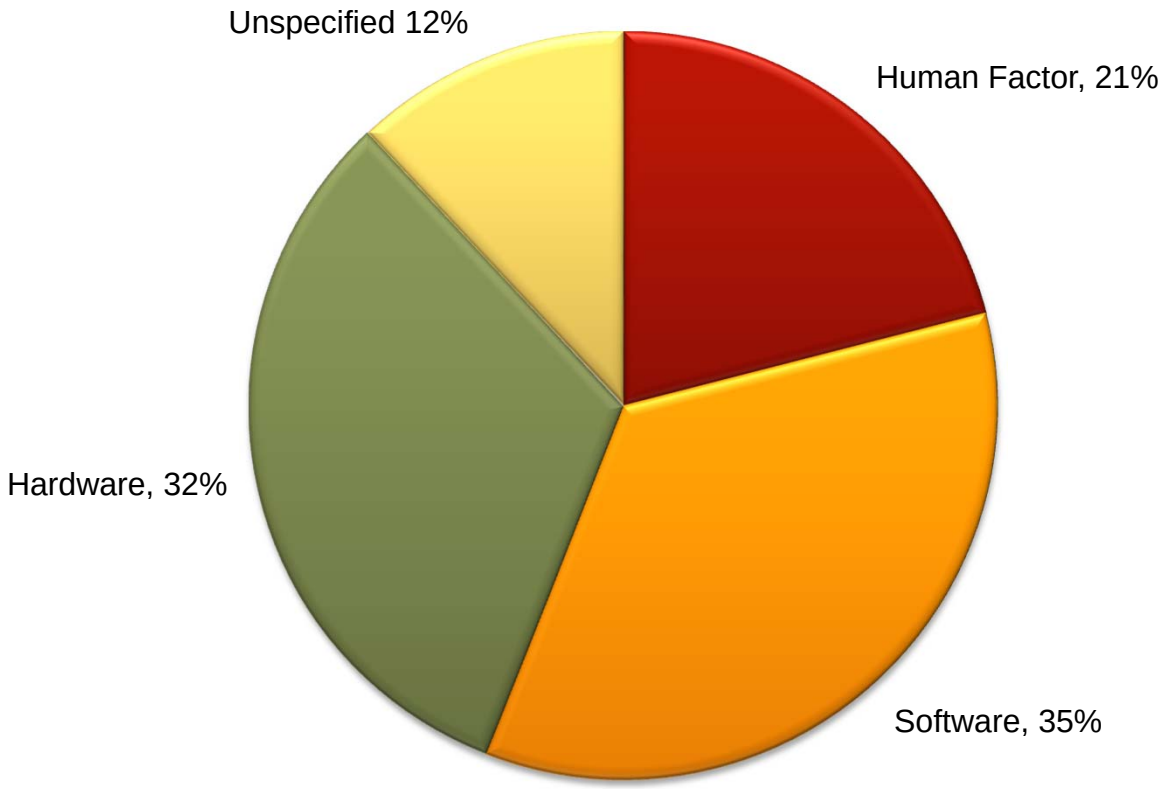


From a 60 building study performed by Lawrence Berkeley National Laboratories

IDC ARCHITECTS

Sources of Control System Problems

CH2MHILL



From a 60 building study performed by Lawrence Berkeley National Laboratories

IDC ARCHITECTS

Types of Control Systems

CH2MHILL

BAS/Commercial Systems

PLC/SCADA Systems

Distributed Control Systems

Cost

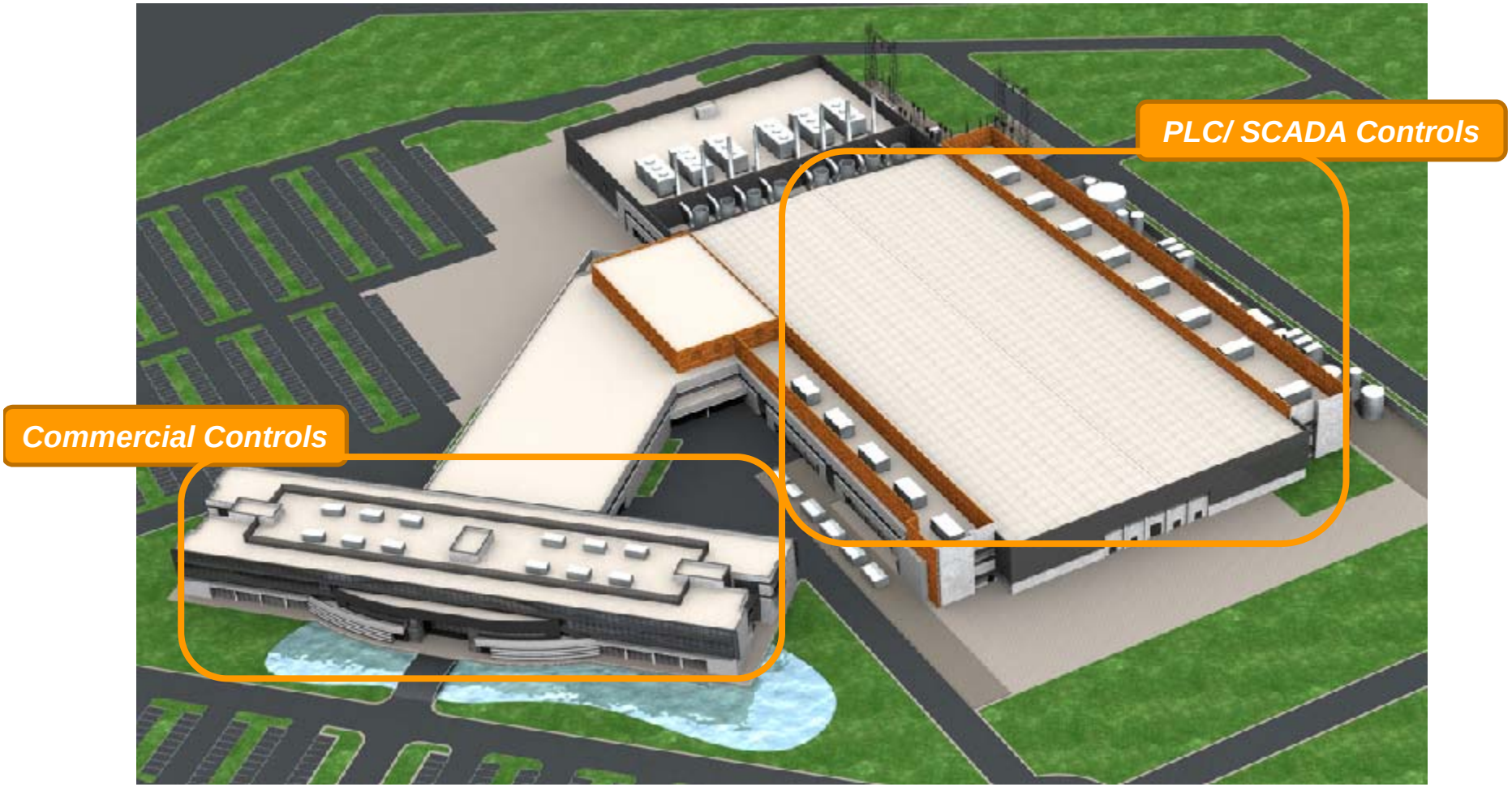
Performance

IDC ARCHITECTS

Types of Control Systems

Which are used in Semiconductor Facilities?

CH2MHILL



IDC ARCHITECTS

Control System Vendors

CH2MHILL

	General Electric	Allen Bradley	Schneider/ Invensys	Siemens	Honeywell
BAS			*	*	*
PLC	*	*	*	*	*
SCADA	*	*	*	*	
DCS	*			*	*

Control System
Elements

CH2MHILL

Devices

- Inputs
- Outputs

Controllers & I/O Modules

- PLC = Programmable Logic Controller (Industrial)
- DDC = Direct Digital Controller (Commercial)

Networks

- Controllers to I/O or lower level controllers
- Supervisory system to Controllers

Supervisory Systems

- SCADA = Supervisory Control and Data Acquisition (Industrial)
- BAS = Building Automation System (Commercial)

Control System
Elements

CH2MHILL

Devices

- Inputs
- Outputs

Controllers & I/O Modules

- PLC = Programmable Logic Controller (Industrial)
- DDC = Direct Digital Controller (Commercial)

Networks

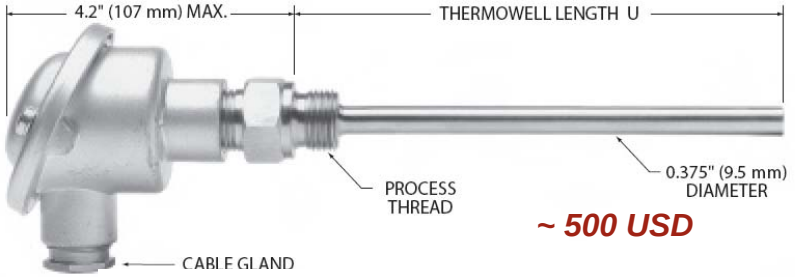
- Controllers to I/O or lower level controllers
- Supervisory system to Controllers

Supervisory Systems

- SCADA = Supervisory Control and Data Acquisition (Industrial)
- BAS = Building Automation System (Commercial)

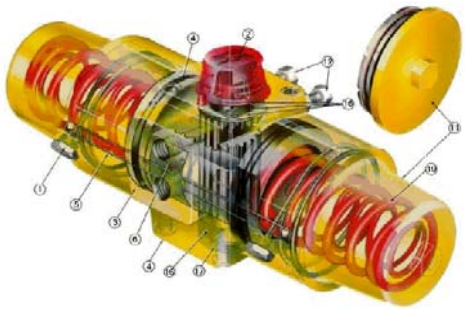
Devices
Input

CH2MHILL

Commercial	Industrial
Temperature Sensor - Johnson Controls  ***~ 100 USD***	*Temperature Sensor - Minco Eurostyle*  ***~ 500 USD***
Liquid Pressure Sensor - Dwyer DSGT  ***~ 500 USD***	 *Liquid Pressure Sensor - Rosemount 3051* ***~ 2000 USD***

Devices
Output

CH2MHILL

Commercial	Industrial
Electric Damper Actuator - Belimo AFA24-SR US  ***~ 300 USD***	 *Pneumatic Damper Actuator - HyTork XL* ***~ 1500 USD***
Electric Control Valve - Johnson Controls VG 700  ***~ 300 USD***	 *Pneumatic Control Valve – Fisher Baumann* ***~ 1500 USD***

IDC ARCHITECTS

Devices
Industrial

CH2MHILL

More rugged

More accurate

More repeatable

Less drift

Easier maintenance/calibration

Control System
Elements

CH2MHILL

Devices

- Inputs
- Outputs

Controllers & I/O Modules

- PLC = Programmable Logic Controller (Industrial)
- DDC = Direct Digital Controller (Commercial)

Networks

- Controllers to I/O or lower level controllers
- Supervisory system to Controllers

Supervisory Systems

- SCADA = Supervisory Control and Data Acquisition (Industrial)
- BAS = Building Automation System (Commercial)

Controllers

CH2MHILL

Commercial

Small DDC
Siemens MEC

Large DDC
Johnson
Metasys NCE

Industrial

Small PLC
Allen Bradley Compact Logix

Large *PLC*
Modicon Quantum

IDC ARCHITECTS

Controllers
Industrial

More rugged

More memory

Faster scan

Richer instruction set

Higher resolution I/O Modules

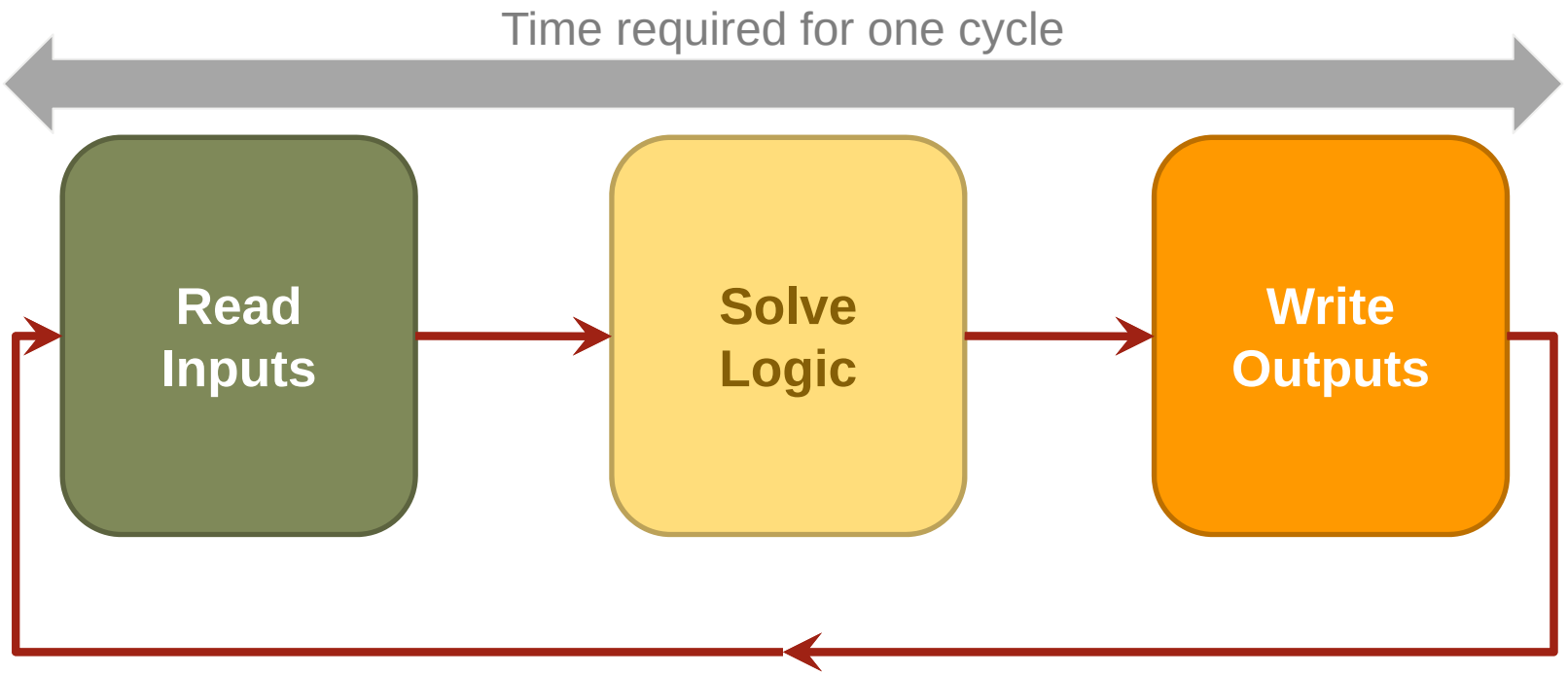
Possible redundancy options

Higher MTBF, lower MTTR

$$\text{Availability} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$$

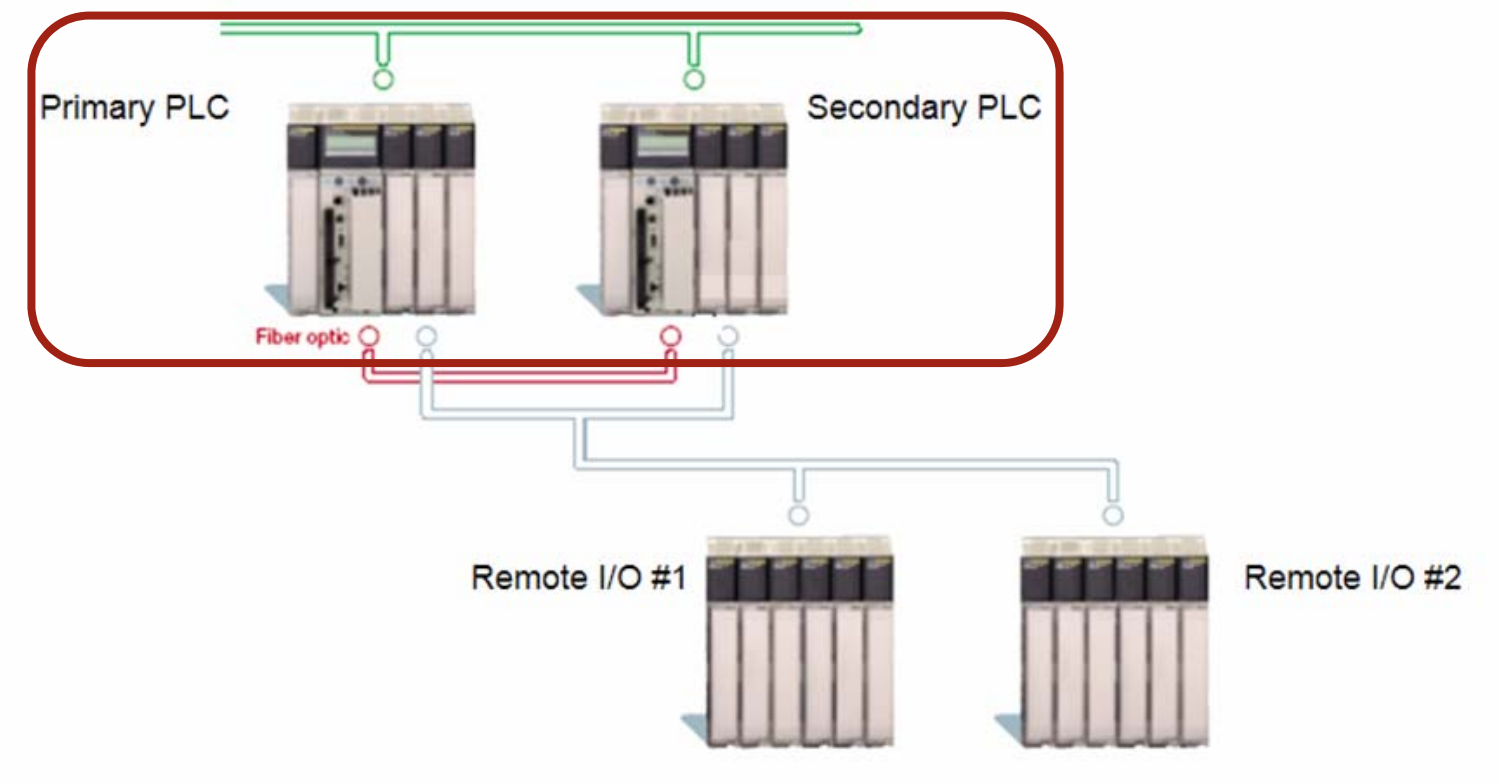
[MTBF = Mean Time Between Failure, MTTR = Mean Time To Repair]

Controllers Scan Rate

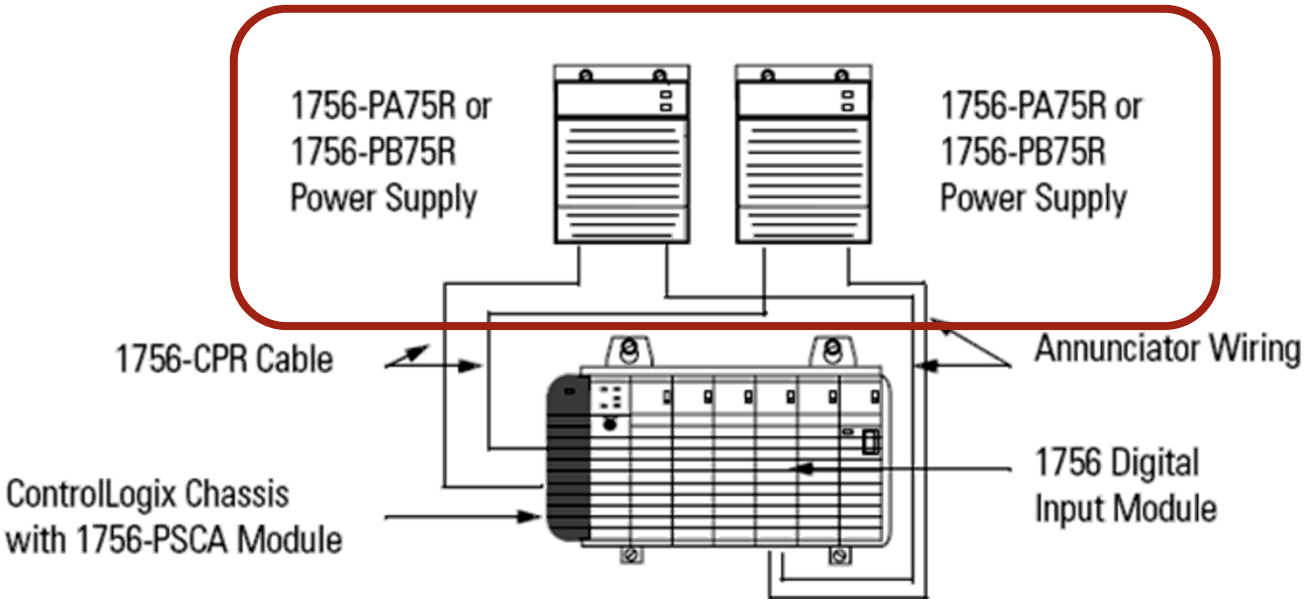


PLC = Milliseconds *DDC = Seconds*

Controllers
Industrial - Redundant Processors

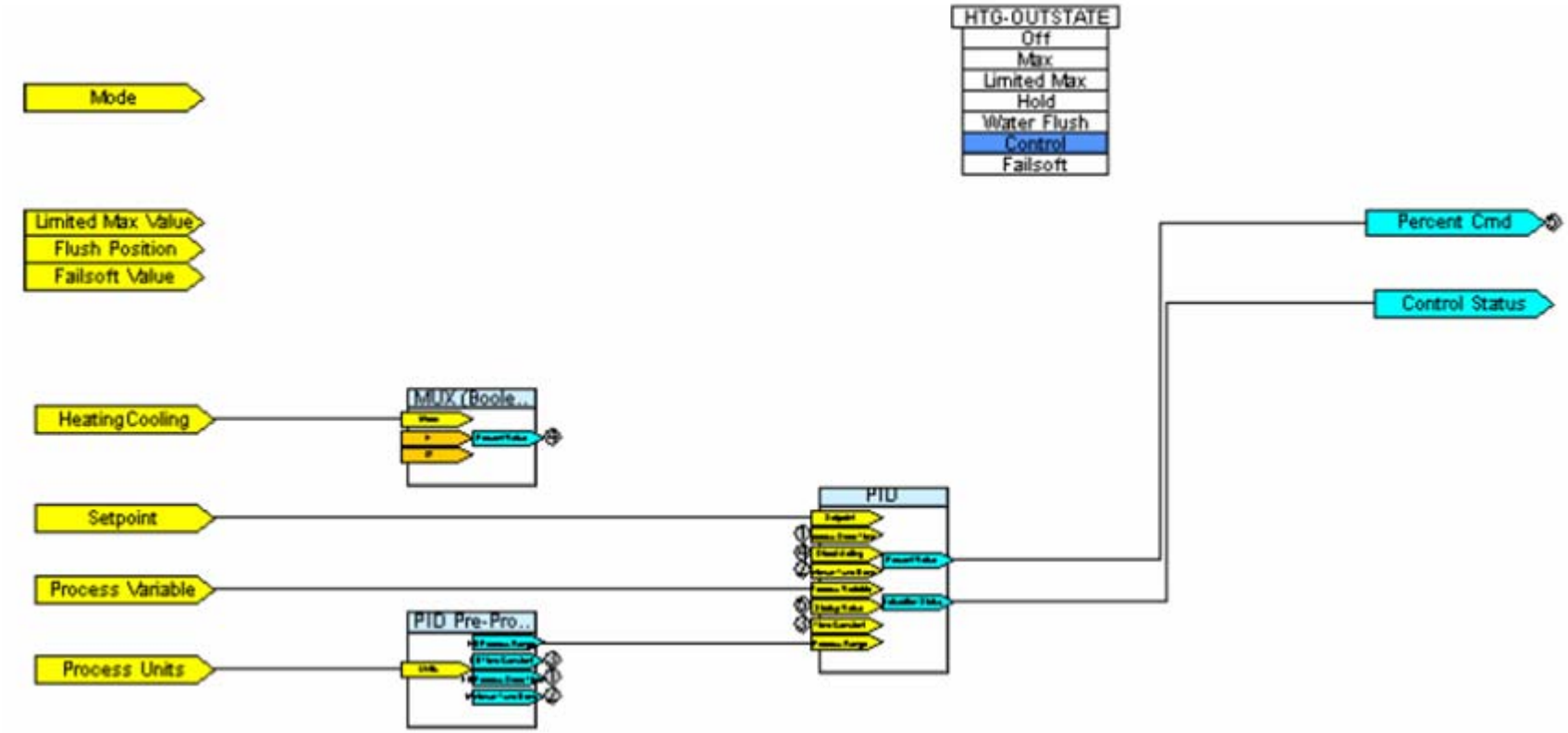


Controllers
Industrial - Redundant Power Supplies



Controllers
Commercial System Programming

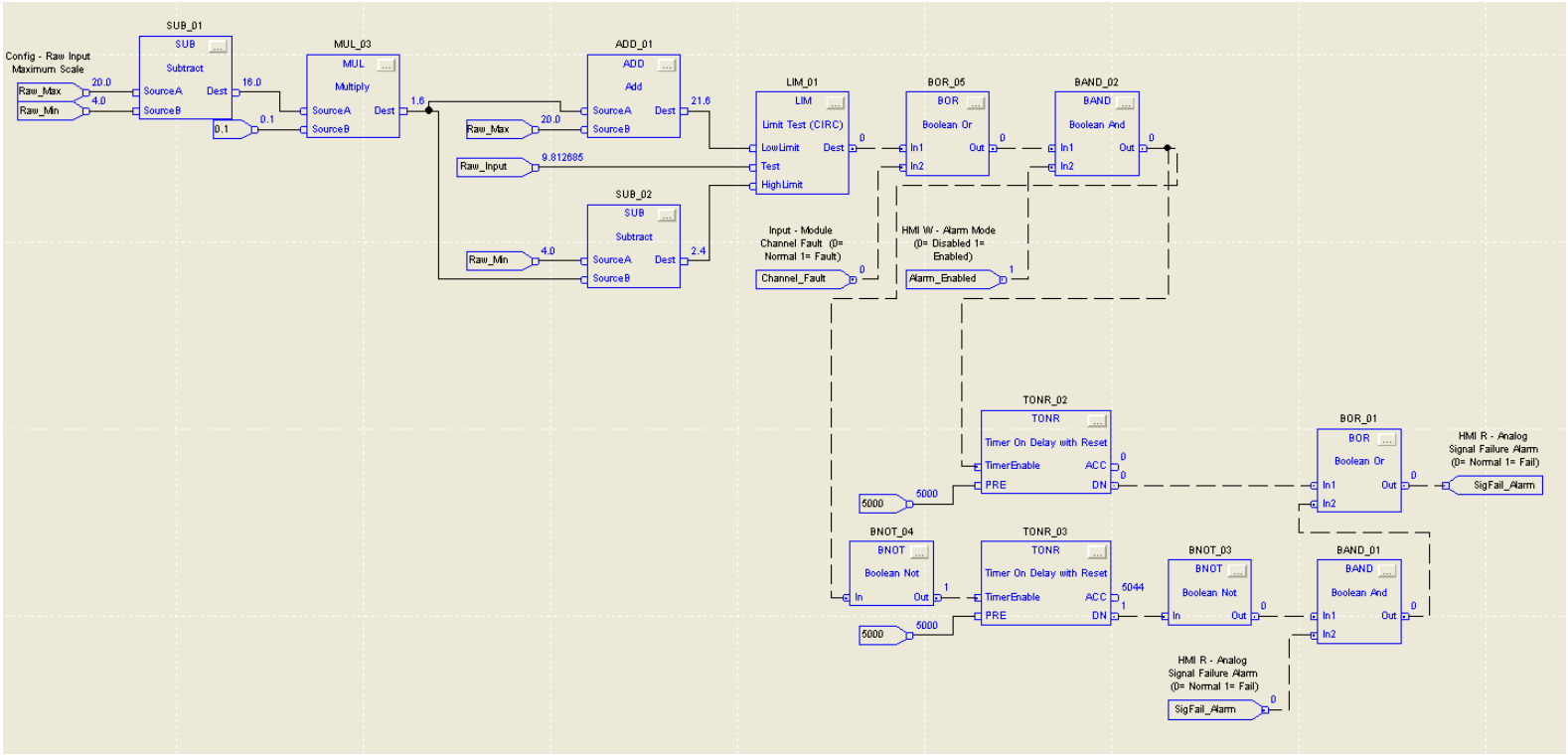
CH2MHILL



Controllers

Industrial - Function Block Programming - Interior

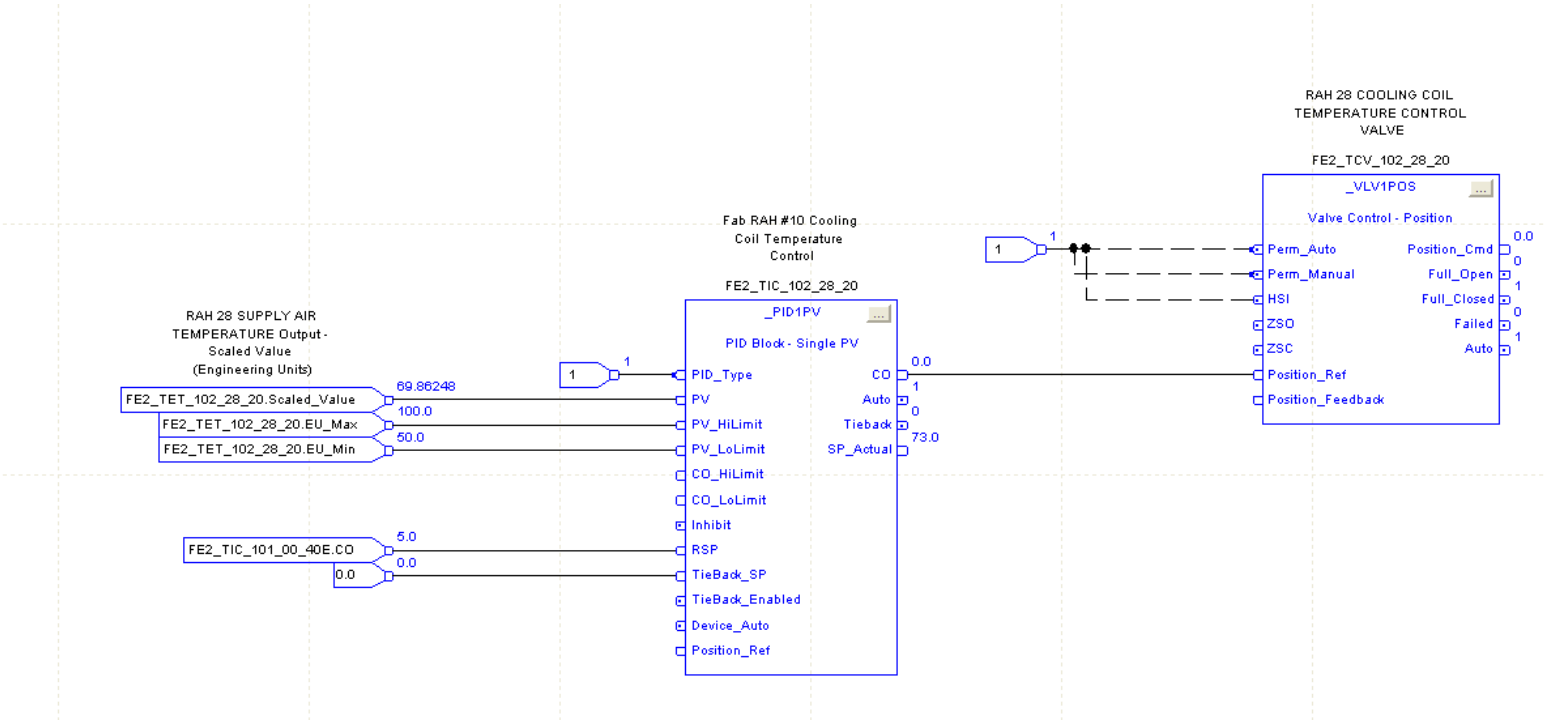
CH2MHILL



IDC ARCHITECTS

Controllers

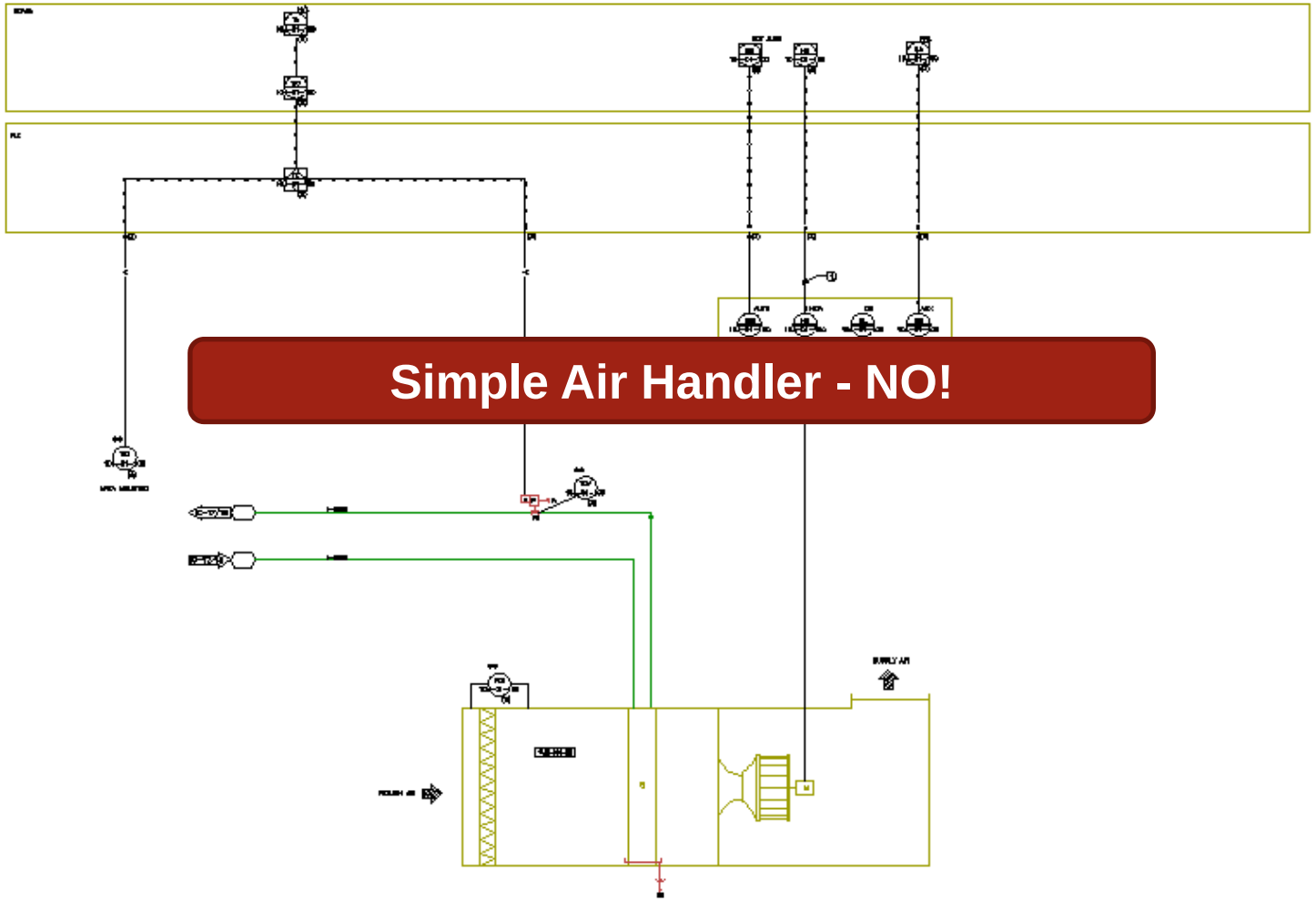
Industrial - Function Block Programming - Exterior



Controllers

Where is programming power required?

CH2MHILL

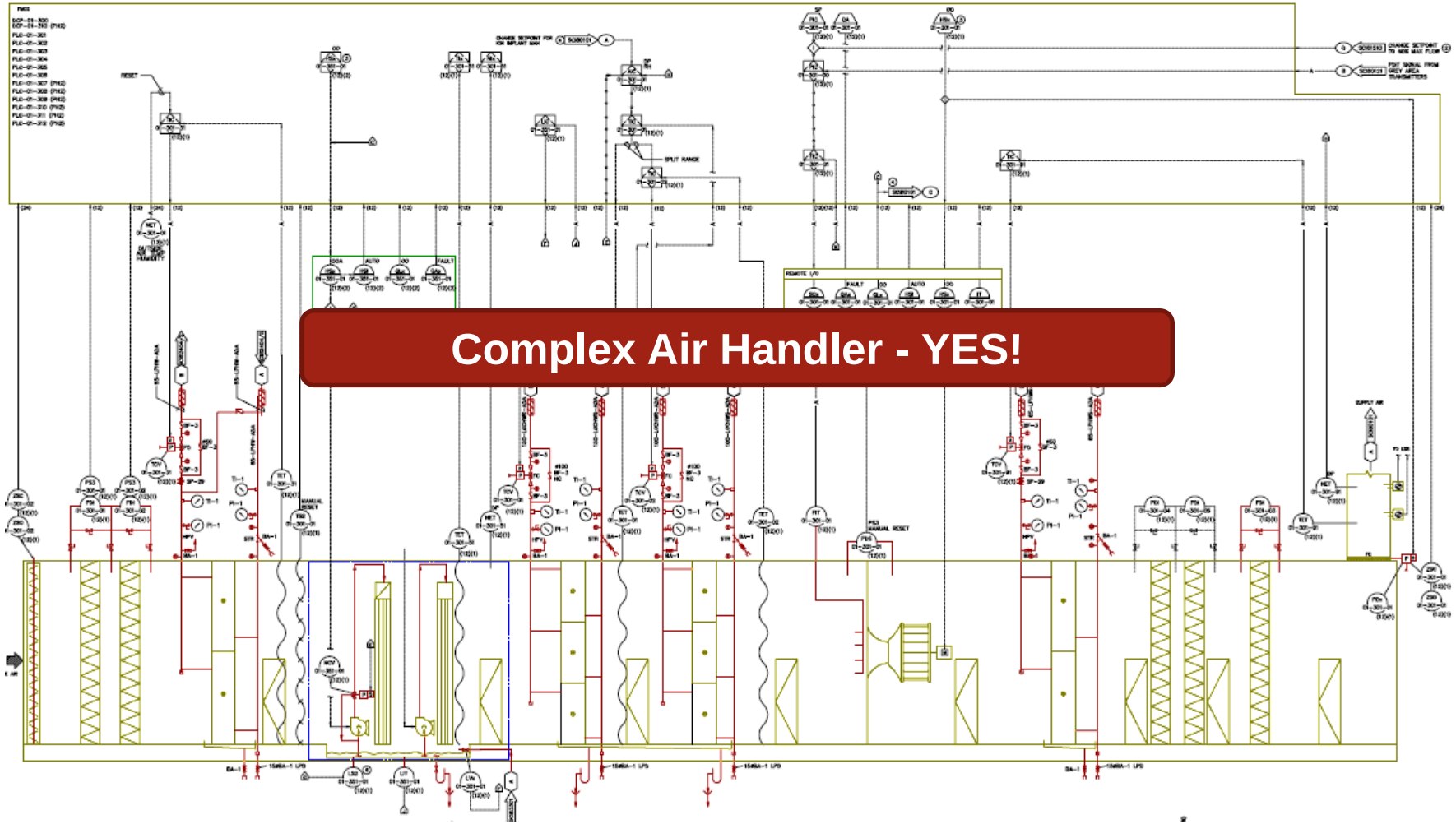


IDC ARCHITECTS

Controllers

Where is programming power required?

CH2MHILL



IDC ARCHITECTS

Control System
Elements

CH2MHILL

Devices

- Inputs
- Outputs

Controllers & I/O Modules

- PLC = Programmable Logic Controller (Industrial)
- DDC = Direct Digital Controller (Commercial)

Networks

- Controllers to I/O or lower level controllers
- Supervisory system to Controllers

Supervisory Systems

- SCADA = Supervisory Control and Data Acquisition (Industrial)
- BAS = Building Automation System (Commercial)

Networks

CH2MHILL

Industrial	Commercial
Profibus	BACnet
Foundation Fieldbus	LonWorks
ControlNet	
Modbus	
DeviceNet	

Networks
Industrial

CH2MHILL

Higher performance

Higher reliability / availability

Better environmental tolerance

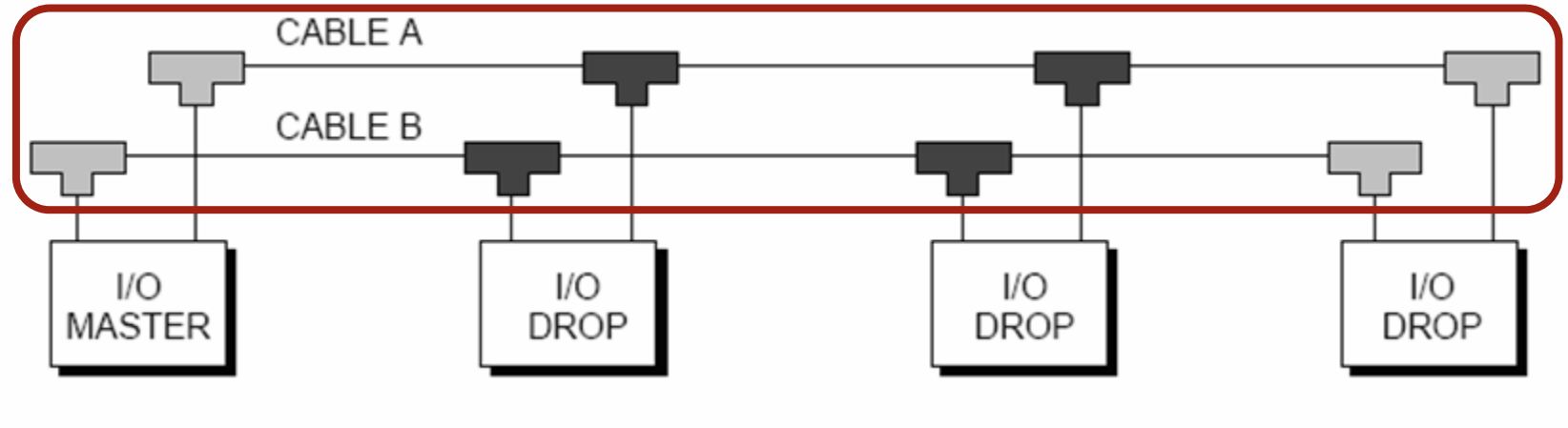
Can be deterministic

Redundancy options

Better diagnostics

Easier maintenance

Networks
Industrial Redundant Network Cables



Control System
Elements

CH2MHILL

Devices

- Inputs
- Outputs

Controllers & I/O Modules

- PLC = Programmable Logic Controller (Industrial)
- DDC = Direct Digital Controller (Commercial)

Networks

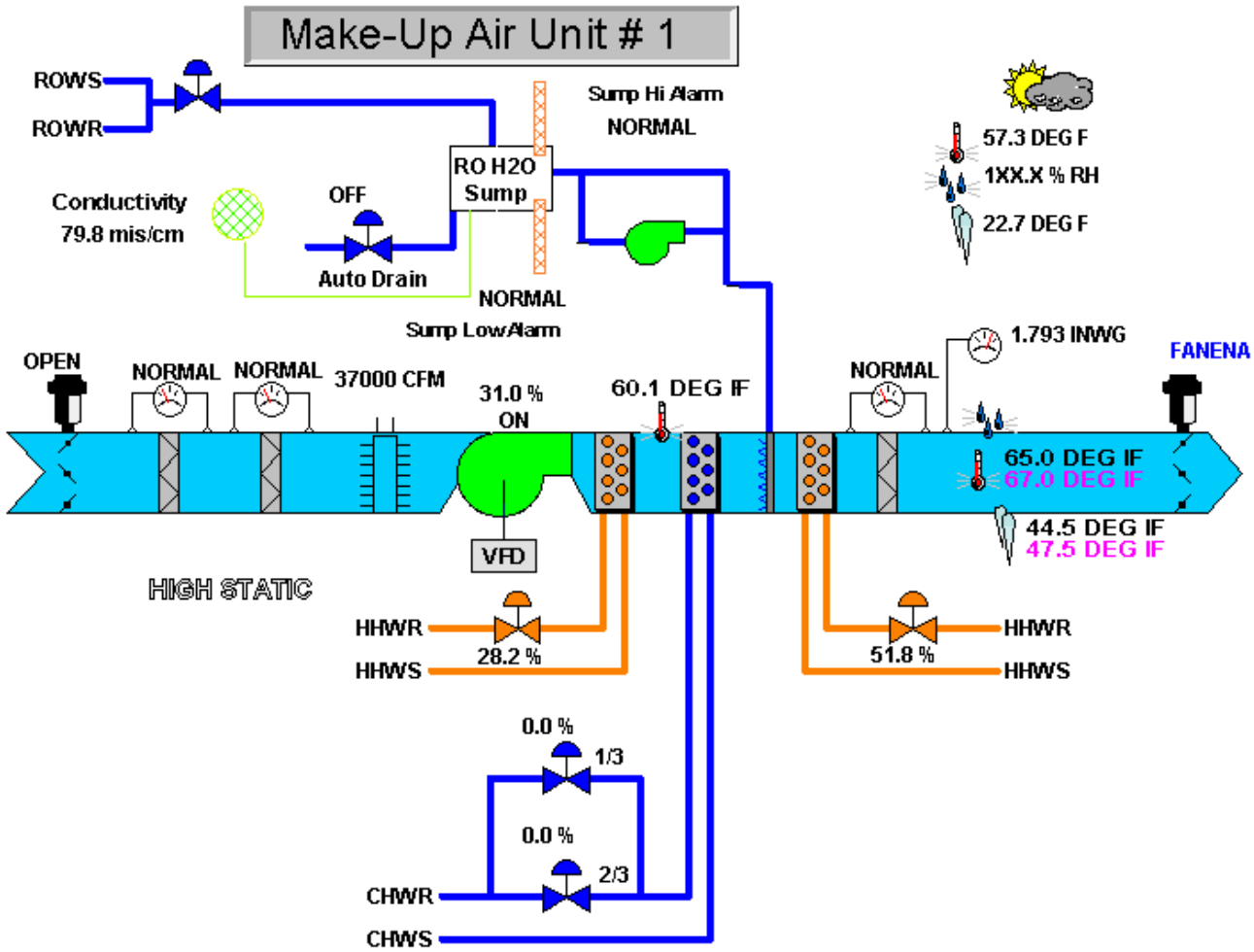
- Controllers to I/O or lower level controllers
- Supervisory system to Controllers

Supervisory Systems

- SCADA = Supervisory Control and Data Acquisition (Industrial)
- BAS = Building Automation System (Commercial)

Supervisory Systems
Commercial - BAS Representation

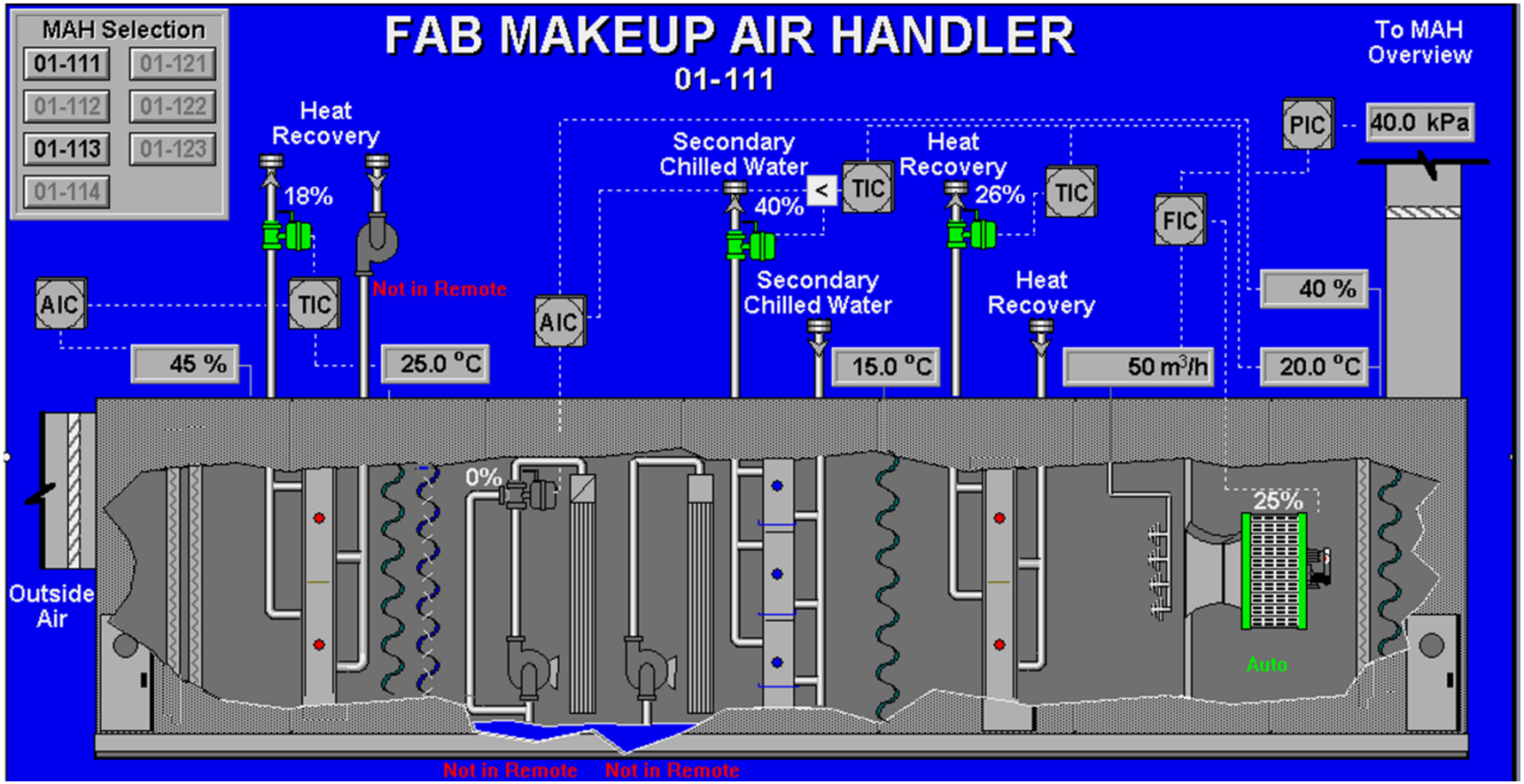
CH2MHILL



IDC ARCHITECTS

Supervisory Systems
Industrial - SCADA Representation

CH2MHILL



IDC ARCHITECTS

Supervisory Systems
Industrial – SCADA

CH2MHILL

- Faster updates
- Faster data logging
- Multiple clients
- Better connectivity
- Redundancy options

Supervisory Systems
Industrial - SCADA Trending

CH2MHILL

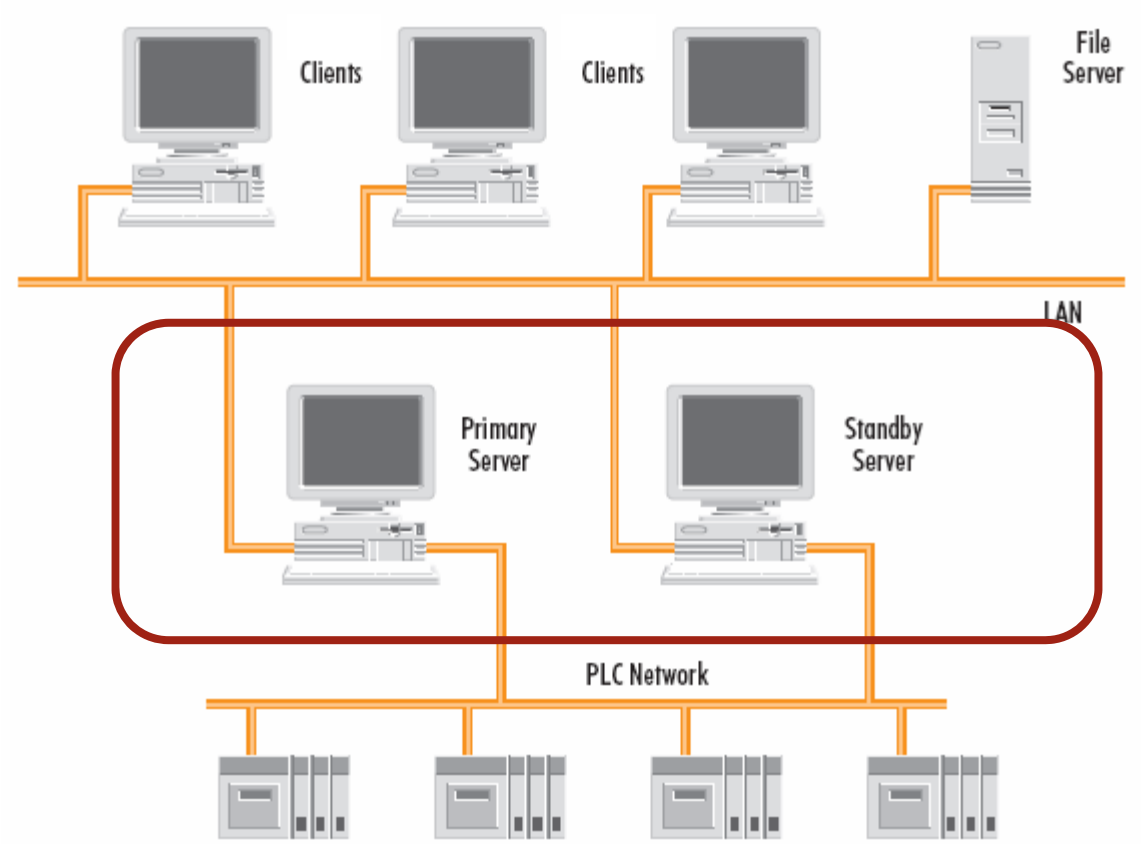
SQL Database

- Accepts High Speed Data
- Compatible with redundant historical servers
- Security and audit trail for government regulations

IDC ARCHITECTS

Supervisory Systems
Industrial - Redundant SCADA Servers

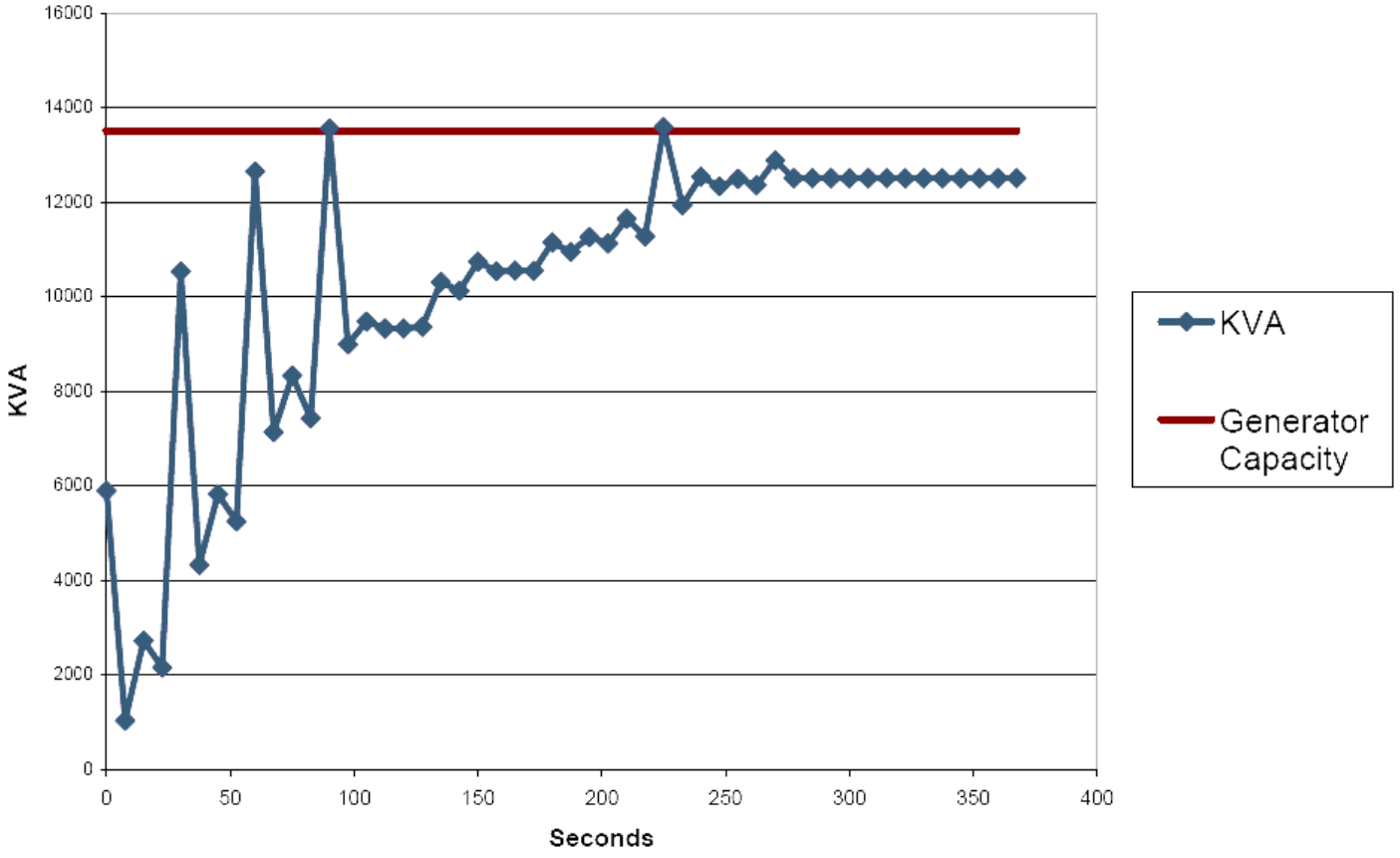
CH2MHILL



Things you can do with Industrial Controls

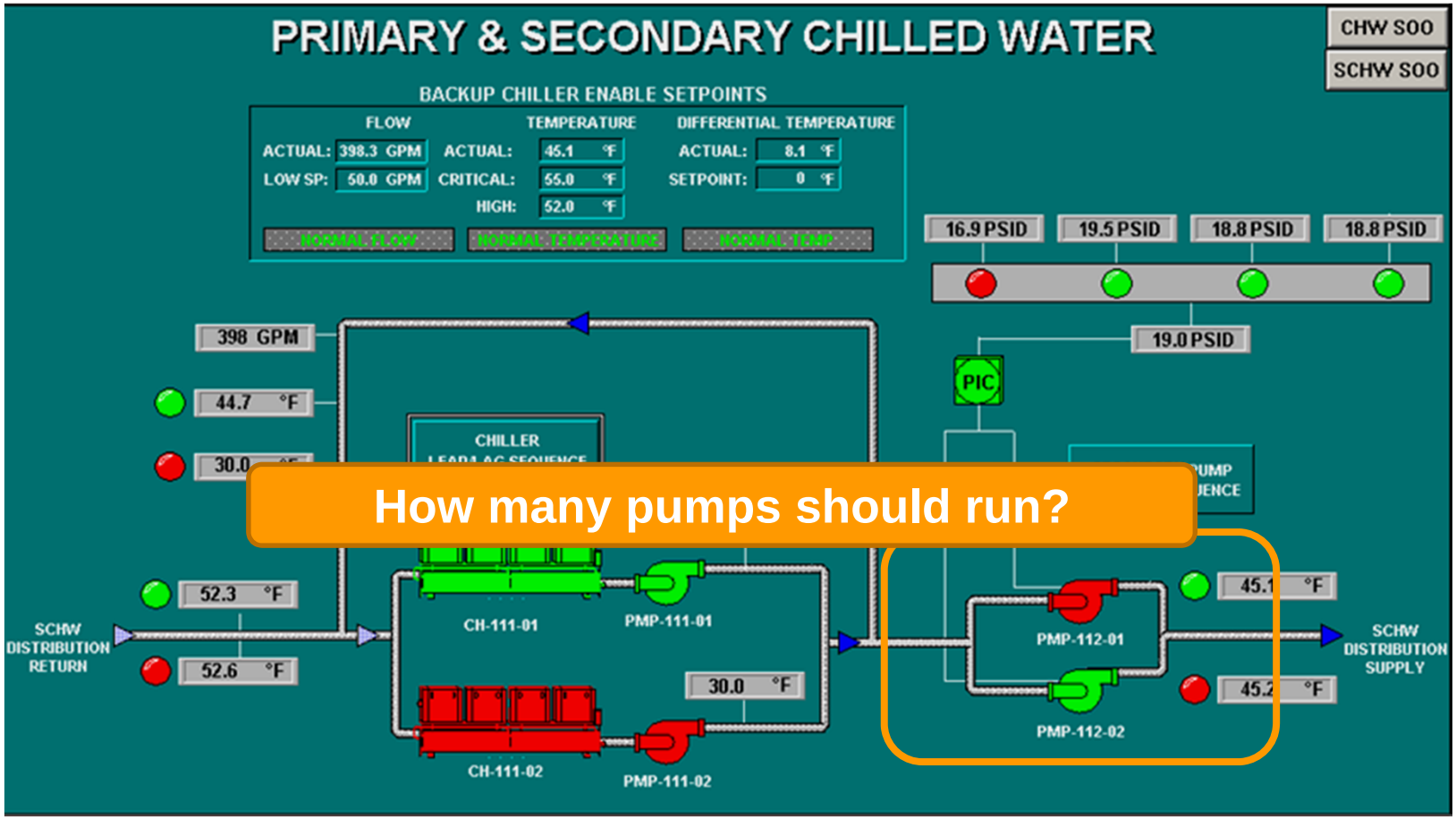
Emergency Power Restart

CH2MHILL



Things you can do with Industrial Controls
Energy Savings

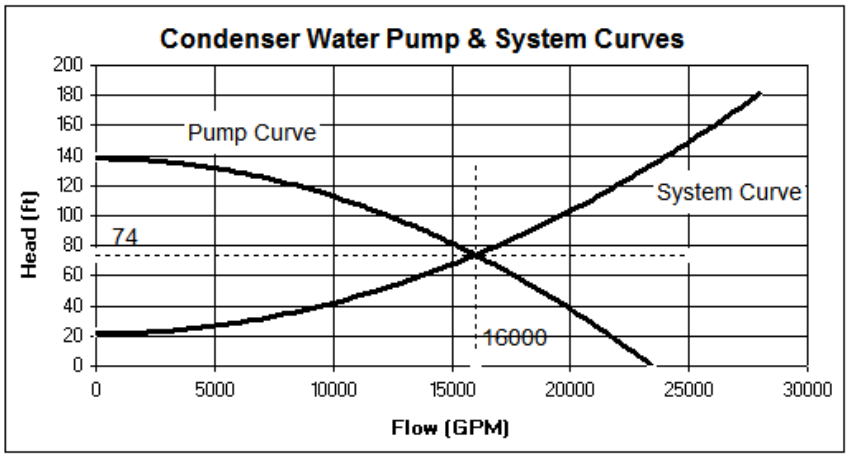
CH2MHILL

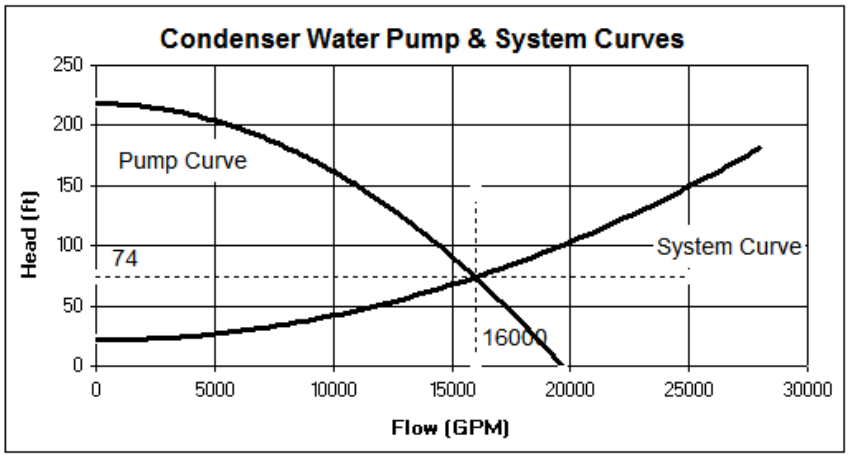


IDC ARCHITECTS

Things you can do with Industrial Controls
Energy Savings

CH2MHILL





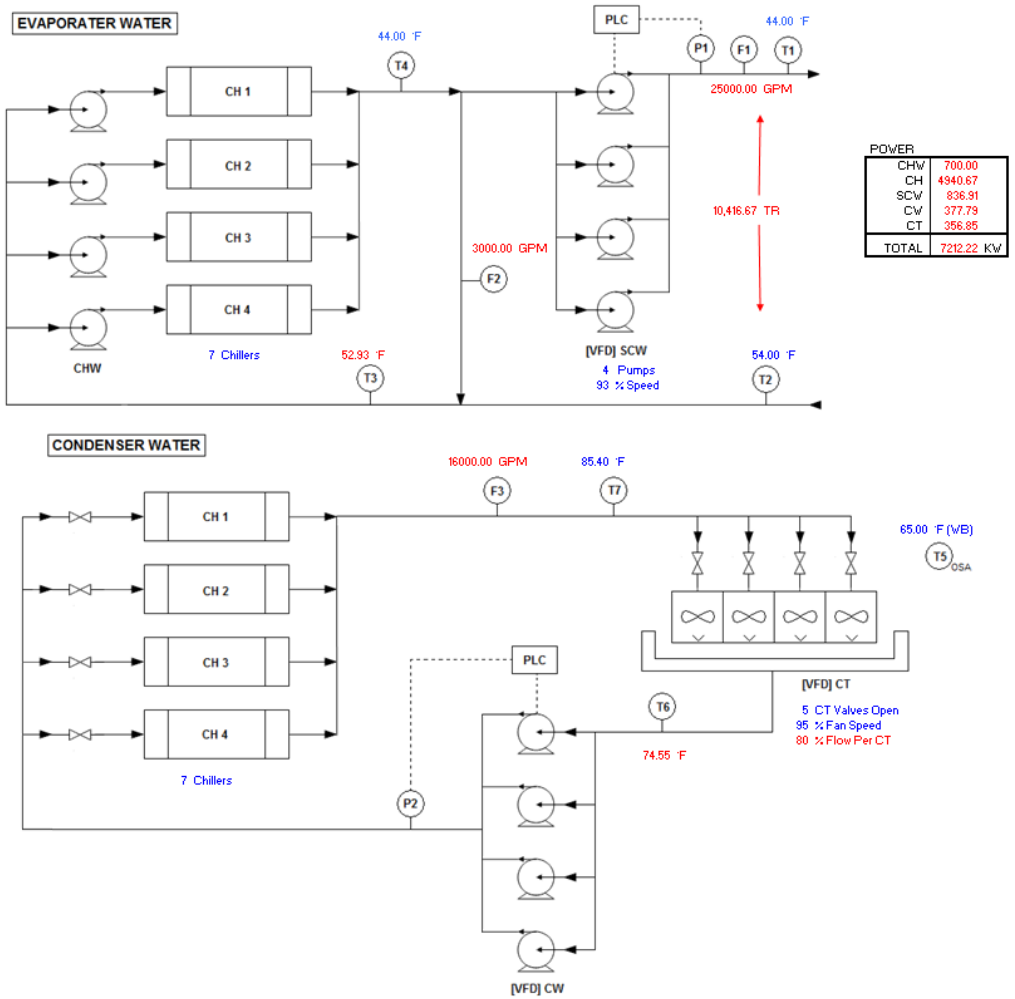
3 pumps @ 59% speed = 378 KW

2 pumps @ 93% speed = 420 KW

Easy to do in PLC *Not so easy in a DDC*

Chiller Plant Optimization

CH2MHILL



IDC ARCHITECTS

More things you can do with Industrial Controls

CH2MHILL

Redundancy vs. Passive automation

Fast PID loops (e.g. pressure control)

Site wide temperature/humidity control

OPC Link with other systems

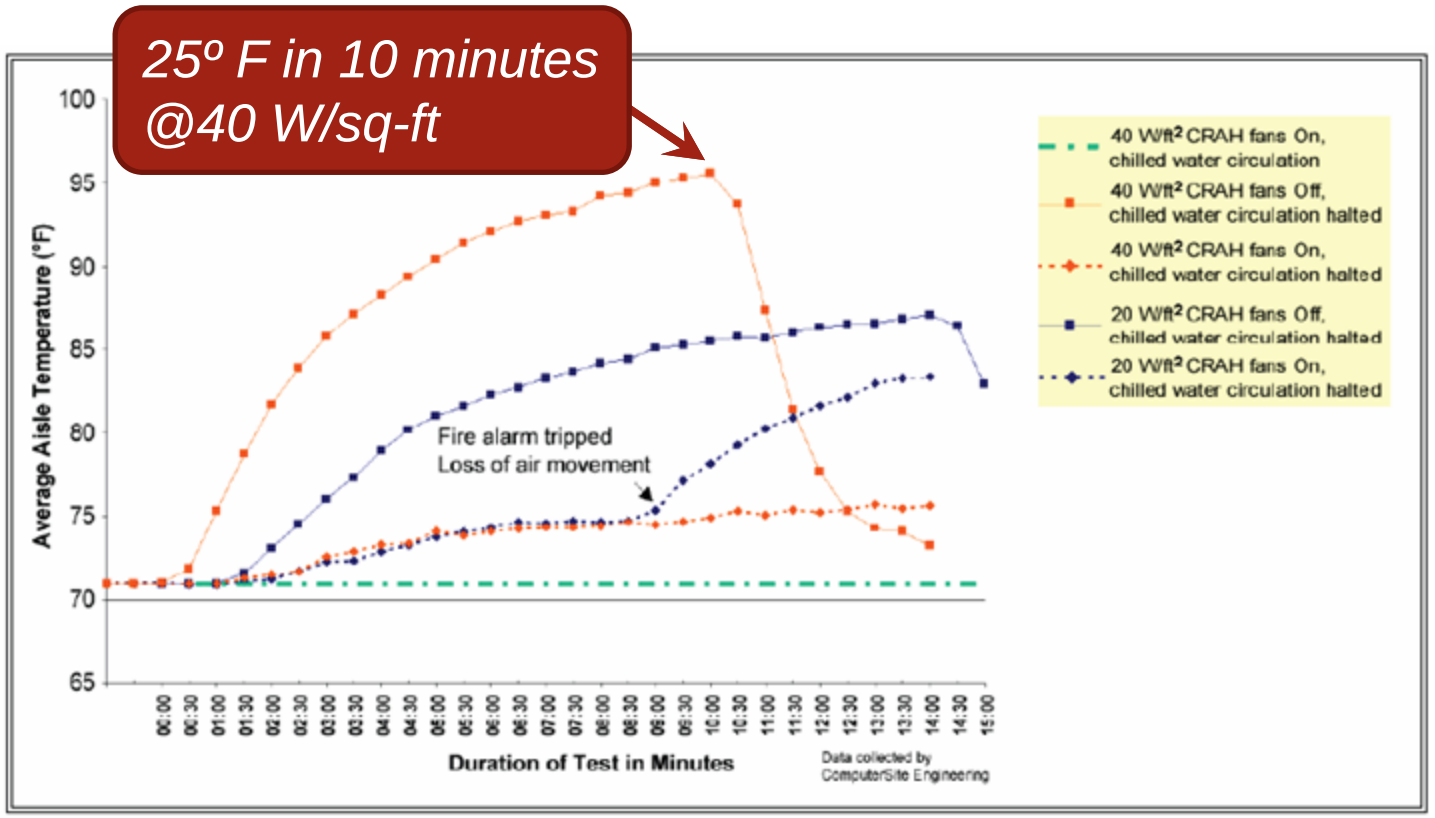
Things you can do with Commercial Controls

CH2MHILL

- Use pre-programmed HVAC sequences
- Scheduling capability
  (night setback, holidays…)
- Link with lighting, security systems
- Purchase a service contract

Consequences of Cooling System Failure

CH2MHILL



From White Paper - "Continuous Cooling is Required for Continuous Availability" - Uptime Institute

IDC ARCHITECTS

Summary

Where to use Industrial Controls: High Tech Cleanrooms

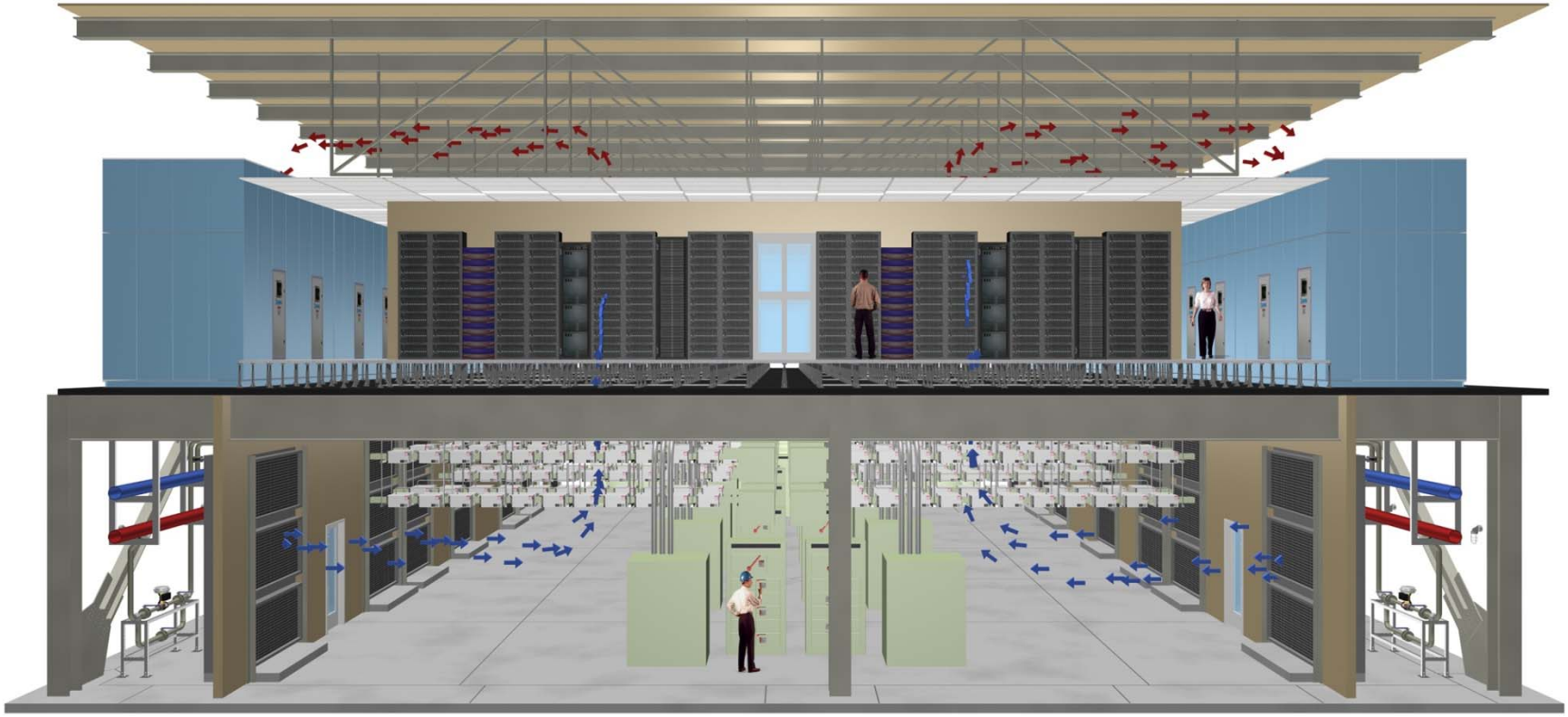
CH2MHILL

IDC ARCHITECTS

Summary Where to use Industrial Controls

High Density Data Centers

CH2MHILL



IDC ARCHITECTS

Summary Where to use Commercial Controls
High School Cafeterias

CH2MHILL

image: Wikimedia Commons

IDC ARCHITECTS

Appendix – Other Examples of PLC controlled Data Centers

CH2MHILL

High Performance Controls Architecture Enables Advanced Energy Management Strategy at Vantage Data Centers

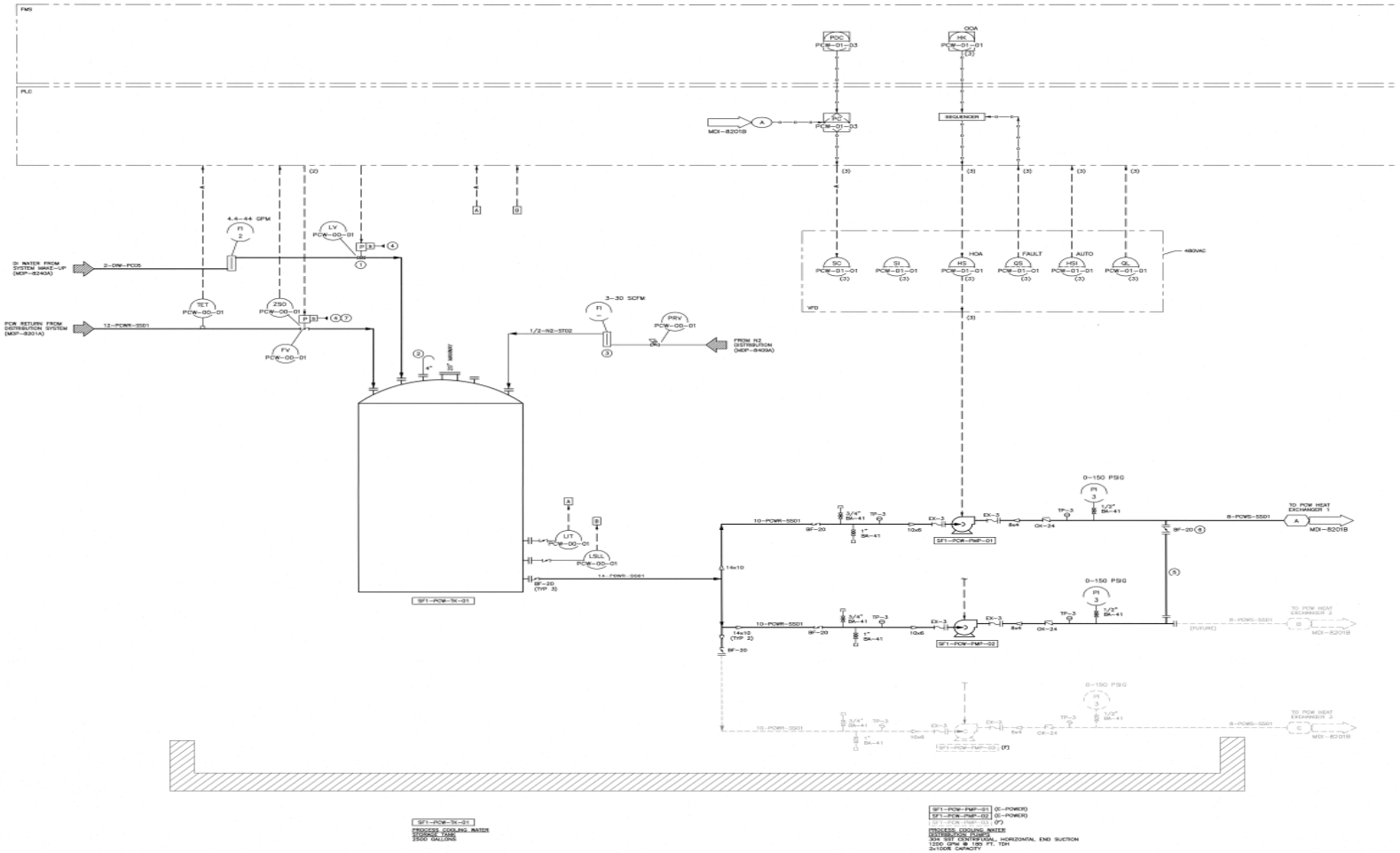
The prevalent HVAC controls solution in data centers and other mission critical facilities is typically a DDC (direct digital control). Some owners and operators have specified and implemented PLCs (programmable logic controllers) to take advantage of the performance and reliability a PLC based control system can offer. As we continue to push the limits to become more efficient, the control algorithms become more complex, a high performance PLC can be a better solution. Vantage Data Centers has implemented a state of the art facility wide PLC based building management system at their Santa Clara campus. During this session Vantage Data Centers will discuss the benefits in energy efficiency and performance they have realized from implementing PLCs for their HVAC controls. We will also review the pros and cons of implementing a DDC vs. PLC in data center BMS systems.

Justin Harp
Director of Operations Engineering
Vantage Data Centers

Warren Jackson
Mission Critical Industry Manager
GE Intelligent Platforms

IDC ARCHITECTS

Appendix – PCW - P&ID - sample



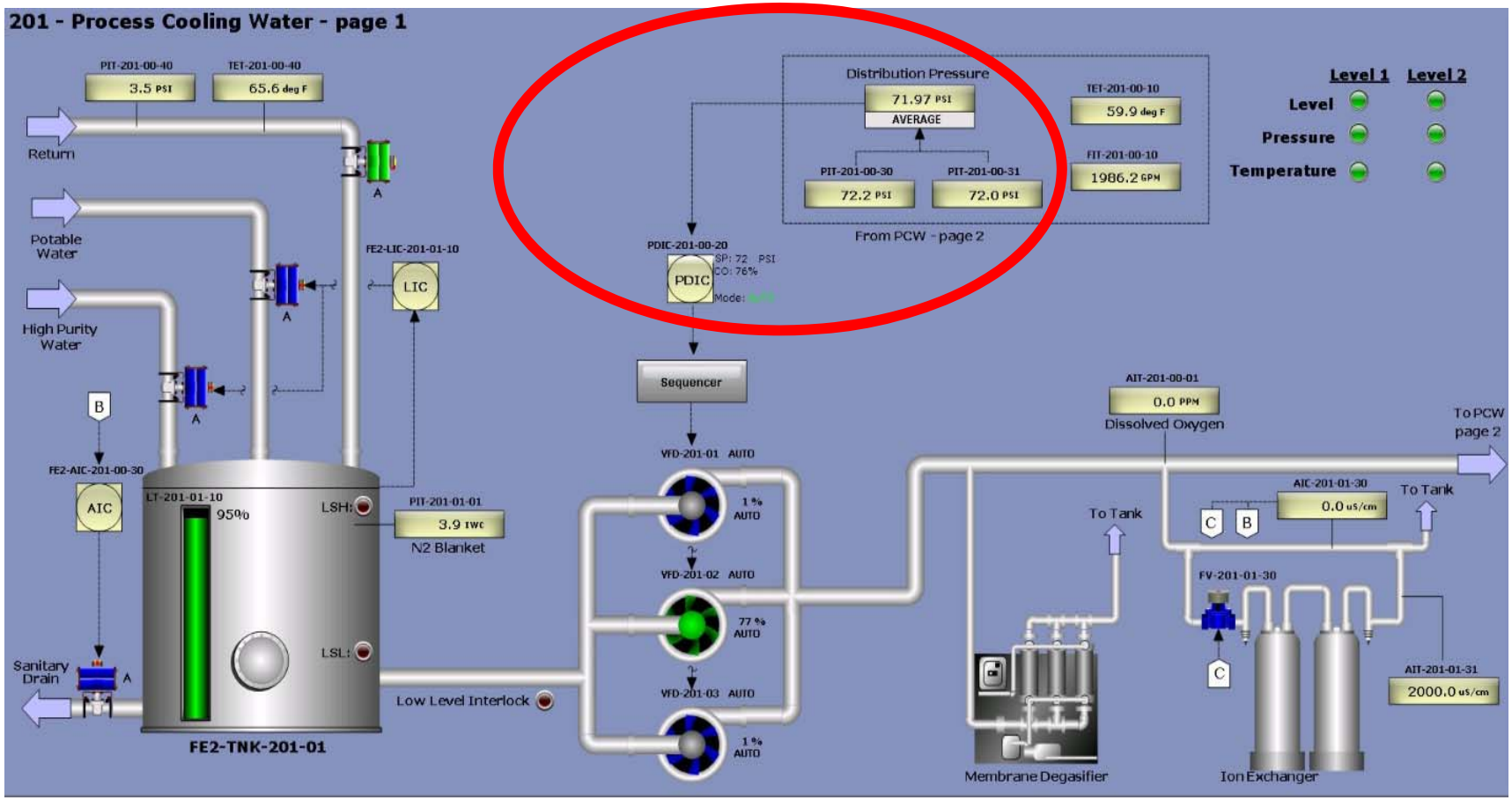
Appendix – PCW - Sequence of Operation - sample

CH2MHILL

Process Cooling Water System Pressure Control:
Two differential pressure transmitters (PDIT-201-00-30 and PDIT-201-00-31) monitor the pressure between the supply and return lines in the distribution. The signal(s) from operator selected transmitters are averaged and the calculated value is used as the input to a PID loop controlling all the operating pumps. The output of the loop pressure controller regulates the speed of the pumps through speed-indicating controllers that vary the output frequency of each operating pump's VFD and sequences the pumps as described above.

If a sensor fails as indicated by loss of signal (below 4ma) an alarm is generated and the sensor is removed from the loop calculation. The signal select block also alarms if the delta between signals exceeds a threshold value. If that occurs, an alarm is generated and the signal furthest from loop setpoint is removed from the calculation. If there are no valid sensor signals the PID loop is placed in manual mode and held at its last value.

Appendix – PCW - SCADA Screen



Appendix – PCW - Instrument Submittals - example

CH2MHILL

Product Bulletin
51.3:Vee–Ball
D101363X012
June 2010

TCV-PCW-01-01

Vee–Ball Valves

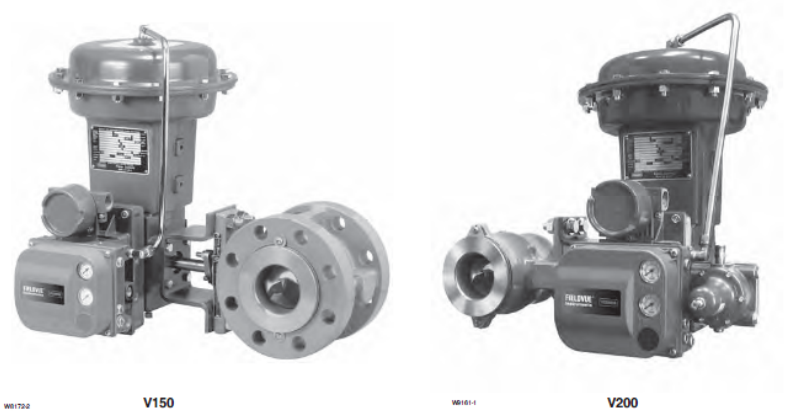
Fisher® Vee-Ball™
V150, V200 and V300 Rotary Control Valves

This bulletin covers the NPS 1 through 2, NPS 3 through 12 Series B, and the NPS 14 through 20 V150, V200 and V300 Vee-Ball control valves (shown in figure 1). The Vee-Ball valve combines globe valve ruggedness with the efficiency of a rotary valve. A shearing action between the V-notch ball and the ball seal (figure 2) promotes smooth, nonclogging operation. The unrestricted straight-through flow design provides high capacity for gas, steam, liquids, and fibrous slurries.

V150, V200, and V300 valves mate with a variety of ASME raised face flanges, as well as with DIN flanges (see Specifications).

To meet specific application requirements, a variety of metal and soft ball seal materials are available. A splined drive shaft combines with a variety of power operated and manual actuators to provide reliable, high-performance throttling or on-off operation for many different applications in the process industries.

Unless otherwise noted, all NACE references are to NACE MR0175-2002.



W8172-2 V150 W8161-1 V200

Figure 1. Typical Vee-Ball Valves with Fisher 1052 Actuators and FIELDVUE™ DVC6020 Digital Valve Controllers

Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Technical Information

Deltabar M PMD55

Differential pressure measurement
Differential pressure transmitter with metal sensor
Communication via HART, PROFIBUS PA or FOUNDATION Fieldbus

PDIT-CW-00-20 MDI-8124A
PDIT-CHW-00-20 MDI-8121A
PDIT-HW-00-10 MDI-8130A
PART NO. PMD55-CD21BD67LGJHAJA1A+AAF1PBZ1

Application

The Deltabar M differential pressure transmitter is used for the following measuring tasks:
- Flow measurement (volume or mass flow) in conjunction with primary elements in gases, vapours and liquids
- Level, volume or mass measurement in liquids
- Differential pressure monitoring, e.g. of filters and pumps

Your benefits

- Reference accuracy: 0,1% as PLATINUM version: up to 0,075%
- Turn down up to 100:1
- Compact transmitter design
- Quick commissioning via DIP switches
- Easy and safe menu-guided operation
  - on-site via display module
  - via 4 to 20 mA with HART
  - via PROFIBUS PA
  - via FOUNDATION Fieldbus
- Continuous modularity for differential pressure, hydrostatic and pressure (Deltabar M, Deltapilot M Cerabar M), e.g.
  - replaceable display
  - universal electronics
- International usage thanks to a wide range of approvals

TI00434P/00/EN/15.11
71128511

Endress+Hauser
People for Process Automation

IDC ARCHITECTS